



Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at <http://about.jstor.org/participate-jstor/individuals/early-journal-content>.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

TWO NEW CASES OF POLYRADIATE CESTODES, WITH A SUMMARY OF THE CASES ALREADY KNOWN

WINTHROP D. FOSTER

Bureau of Animal Industry, United States Department of Agriculture

Anomalies in adult cestodes are by no means uncommon and have been reported by numerous investigators in the last two centuries. These may be divided into those which affect only part of the worm and those which are characteristic of the entire strobila. Among the former are supernumerary proglottids, fenestrated segments, bifurcation of the strobila at the posterior end, branching at the side, forming a short chain of proglottids arising from a supernumerary proglottid, fusion of the line of separation of the proglottids through part of the strobila, and inversion of the usual arrangement of the sexual organs. Supernumerary proglottids are usually formed by the insertion of a smaller incompletely developed proglottid, into an otherwise normal proglottid (Fig. 1) or the supernumerary proglottid may be triangular and extend the entire length of the lateral edge of the proglottid to which it is attached. Fenestrated proglottids in which the central portion of the parenchyma is lacking are usually confined to a few segments, but in a few cases have involved nearly all the segments of the strobila. Fusion may be complete throughout a large number of proglottids or the line of demarcation between the proglottids may be obliterated only partially, giving the appearance of an excessively long proglottid on one side and two or more normal proglottids on the other, as in McCulloch's (1913) case.

Of more immediate interest are the cases of triradiate strobilae, in which the entire strobila instead of being flat or ribbon like, as in the normal tapeworm, has a central ridge extending uniformly throughout all the proglottids and giving a triradiate figure when seen in cross-section. This anomaly may also be combined with the anomalies affecting individual proglottids mentioned in the preceding paragraph. Twenty-eight such cases have been collected by Vigener (1903) and are summarized in the accompanying table. To this list I have added five more cases, one of them not hitherto reported.

EXTERNAL ANATOMY OF POLYRADIATE CESTODES

Analogous to the triradiate forms are those in which the tapeworm has more than three wings. Such forms are far less common, and if we except Leuckart's case (1880), which he considered as a fusion

of two triradiate forms, but which Barrois (1893) concludes is a case of simple triradiate proglottids having a simple supernumerary proglottid attached to one of the wings, only one case (Rosenberger, 1903) has hitherto been reported. In Rosenberger's case the parasite was pentaradiate, forming a star-shaped figure. As Rosenberger, however, does not specify the exact shape of the proglottids other than to describe them as "star shaped," and as his observation was published in a journal not readily accessible to European helminthologists, it has been largely overlooked and the existence of strobilae having more than three wings is not mentioned in any of the text-books. In the present paper a tetraradiate proglottid of *Taenia saginata* is described. The term *polyradiate* is suggested as a convenient word for describing all cases of adult cestodes in which the strobila is formed of three or more wings radiating from a common axis.

With but one exception, all triradiate cestodes in which the head has been recovered have been found to have six suckers instead of the usual four; the triradiate feature extending throughout the scolex, as is well seen in Vigener's (1903) case. In Rudolphi's (1810) case, however, the scolex is described as normal. Considering that the principal feature of this anomaly is its uniformity throughout the entire strobila, and that Rudolphi's case is the only exception recorded, the correctness of his observation has been questioned. It is therefore logical to assume that a cysticercus with six suckers represents the larval stage of a triradiate cestode, and this view is generally accepted by helminthologists. Such cases are included in Vigener's (1903) list of triradiate cestodes on which the present table is based.¹ In all, forty-four cases of polyradiate cestodes (larvae and adults) have been reported. The number of individual specimens reported is, however, much greater, since two writers, Zürn (1898) and Railliet (1899), report seeing "several" larval cestodes having six suckers, and three other writers each describe two or more adult specimens.

By far the greater number of polyradiate forms are found in *Taenia saginata*, twenty-four adult cestodes of this form having been described. Of these twenty-four cases, two (Andry, 1741, and Brera, 1811) are so indefinite as to be doubtful, and in four other cases the distinction between *Taenia solium* and *Taenia saginata* has not been made. These cases are assigned to *T. saginata*, since this parasite is more common than *T. solium* in the regions where the cases were observed. Among the twenty-four cases is one pentaradiate form (Rosenberger, 1903) and one tetraradiate (Foster, the present paper).

1. Vigener's article includes a complete bibliography of all cases of triradiate cestodes then known.

In four species, *Taenia saginata*, *T. solium*, *T. pisiformis*, and *T. coenurus*, larval forms with six suckers have been found as well as the adult triradiate forms. Summarizing the cases the number of individual specimens reported are:

Adult cestodes		Larval cestodes	
Species	Number	Species	Number
<i>Anoplocephala perfoliata</i>	1	<i>Coenurus cerebralis</i>	2
<i>Bothriocephalus latus</i>	1	<i>Coenurus serialis</i>	Several
<i>Bothriocephalus tectus</i>	Several	<i>Cysticercus bovis</i>	1
<i>Dipylidium caninum</i>	1	<i>Cysticercus cellulosae</i>	2
<i>Taenia coenurus</i>	3	<i>Cysticercus pisiformis</i>	1
<i>Taenia echinococcus</i>	1	<i>Cysticercus tenuicollis</i>	Several
<i>Taenia pisiformis</i>	1		
<i>Taenia saginata</i>	24		
<i>Taenia solium</i>	2		
<i>Taenia taeniaeformis</i>	2		

It appears from the column in the table showing the localities where polyradiate cestodes have been found that this anomaly is as widespread as the geographical distribution of the cestodes themselves. That more cases have been reported from Germany and France than elsewhere, is apparently due to the greater attention which has been given to the subject of teratological forms in these countries.

In most cases of adult polyradiate cestodes the scolex has not been recovered. Twenty-four writers have recorded cases of *Taenia saginata*, but five of them only have observed the head. This is probably due to the fact that these specimens were recovered from the living hosts by vermifuges instead of at autopsy, and were therefore more liable to damage. The fact that cases of polyradiate cestodes have been found far more commonly in *Taenia saginata* than in other species may be due to a greater frequency of variation characteristic of this species, as suggested by some helminthologists, but may also be explained by the fact that this species, being a common parasite of man, is perhaps more frequently observed than any other species. This opinion is supported by the fact that most of the cases are reported by practicing physicians who have many opportunities to observe this species and little chance to study other species not parasites of man. If this species were especially subject to this anomaly we should expect to find a correspondingly large number of *Cysticercus bovis* with six suckers, yet only one such case has been reported.

A triradiate cestode usually has an unpaired wing, smaller than the other two wings, which are usually of nearly equal size. Sometimes these equal wings lie close together, as in MacCallum's (1912) case, giving the worm the appearance of a normal cestode split lengthwise through half its width. Usually, however, the wings are thickened at the base so that they are separated from one another, giving a triradiate appearance. The unpaired wing may be so reduced as to form a mere ridge along the center of an otherwise normal parasite, as in

Jelden's (1900) case, or it may be so well developed as to be equal in size and symmetry with the other wings, giving a perfectly symmetrical figure, as in Yoshida's (1913) case.

The number and arrangement of the genital pores are subject to considerable variation. In most cases there is a single pore in each segment, located on the margin of the unpaired wing. Thus all pores are unilateral, an arrangement in striking contrast with the normal arrangement in the genus *Taenia* in which the pores are irregularly alternate. There are, however, many exceptions to this rule. In Bremser's (1819) case of *T. saginata*, according to Rudolphi (1819) the genital pore was in most cases located on the unpaired wing, but three variations were seen: (1) genital pore not on the unpaired wing but on the edge of one of the paired wings; (2) genital pore on the unpaired wing and on the edge of one of the two paired wings; (3) genital pore on the unpaired wing and on each of the paired wings. Two proglottids each had two genital papillae on the same unpaired wing, one located anteriorly, the other posteriorly. In Küchel's (1892) case, according to Vigener (1903), who re-examined his material, one segment bore three papillae and several segments had two sexual openings. As a rule there was but one sexual opening to each proglottid on the edge of any one of the three wings. In Bork's (1891) case although the unpaired ridge was papilliferous throughout, a supernumerary proglottid had a genital pore in the crevice between two of the wings. In Yoshida's (1913) case of *Taenia taeniaeformis* (*T. crassicollis*), "the genital pore is usually single in each segment, situated on any one wing of the worm, but there are sometimes two genital pores lying respectively on any two wings of the segment". In von Linstow's (1892) case of *Bothriocephalus tectus*, the genital pores are all situated on the middle line of the ventral surface, the normal position for cestodes of this genus.

The triradiate form in cestodes is not infrequently associated with the more common anomalies of supernumerary proglottids, forking, and fenestration. Both forking and supernumerary proglottids were observed by Vigener (1903) and Cattaert (1899). In the cases of Cattaert (1899) and Coats (1891), the worm ends in a triple fork, each branch forming one wing of the triradiate strobila. In McCulloch's (1913) case both fenestrated and supernumerary segments were frequent. The fenestration involved only mature segments, usually extending through two adjacent segments and following the line of the unpaired ridge. Asymmetrical segments were formed by the line of division between segments extending through only one or two of the three lateral wings, the opposite wing or wings being equal in length to the sum of these asymmetrical segments.

INTERNAL ANATOMY

The internal anatomy of polyradiate cestodes does not as a rule, present any special variation from the normal except in so far as the arrangement of the organs is associated with the peculiar external form. The extra wing or wings are as fully developed internally as the normal part of the cestode. The uterus, having its main stem running through the center of the polyradiate proglottid, sends off lateral branches into each of the wings irrespective of their relative size. Thus in Jelden's (1900) case, although the unpaired wing is here reduced to a mere ridge, it contains its full share of the uterine branches. The longitudinal excretory canals and longitudinal nerves, which in normal taeniae extend along each lateral margin of the cestode, are, in polyradiate forms, found in the same relative position in each of the wings. Several minor variations from the normal have been recorded. Both Neveu-Lemaire (1900) and Cattaert (1899) observed that the transverse muscle fibers at the point where the three wings separate occasionally formed a partition wall separating one wing from the other two. In Neveu-Lemaire's (1900) case the longitudinal canal in the unpaired ridge was larger than the other two. The ovaries lay in the posterior portion of the proglottid in the center of the "Y," ramifying into the two equal wings but not into the unpaired wing. Yoshida (1913) finds that in his specimen of *Taenia taeniaeformis*, the testes are distributed throughout the three wings and not confined to the dorsal side as in normal specimens of this species. The eggs of triradiate cestodes are usually reported as normal, but Küchel (1892) reports that out of ten eggs which he examined, one was normal, seven had eight hooklets arranged in pairs, and two had ten hooklets including one that was very small and incompletely developed.

THE WRITER'S CASE OF A TRIRADIATE TAENIA PISIFORMIS

Although Railliet (1892) has reported a case of *Cysticercus pisiformis* having six suckers, no case of an adult triradiate cestode of this species has yet been published. The present example was found in a mass of tapeworms expelled by an imported collie dog held at quarantine in Athenia, N. J., and treated with a taeniafuge for tapeworm infestation, which had been diagnosed from a microscopic examination. The mass of tapeworms received at this laboratory consisted of a great many fragments which were roughly estimated as belonging to from seventy-five to one hundred individuals, all of which, as far as examined, were of the same species, *Taenia pisiformis*. Although the entire mass was examined in a petri dish, no scolices were found. The identification of the species was verified by feeding experiments on a

rabbit. In this mass a number of chains of triradiate proglottids were found, the longest piece being 23 cm. representing the anterior half of the worm, except the head. In all about 52 cm. of the worm were recovered.

The parasite is uniformly triradiate throughout its entire length, the three wings being of almost equal size and having the same angle between them (Fig. 1). The wings are thickened at the base, thus maintaining the symmetry of the figure. Owing to shrinkage from

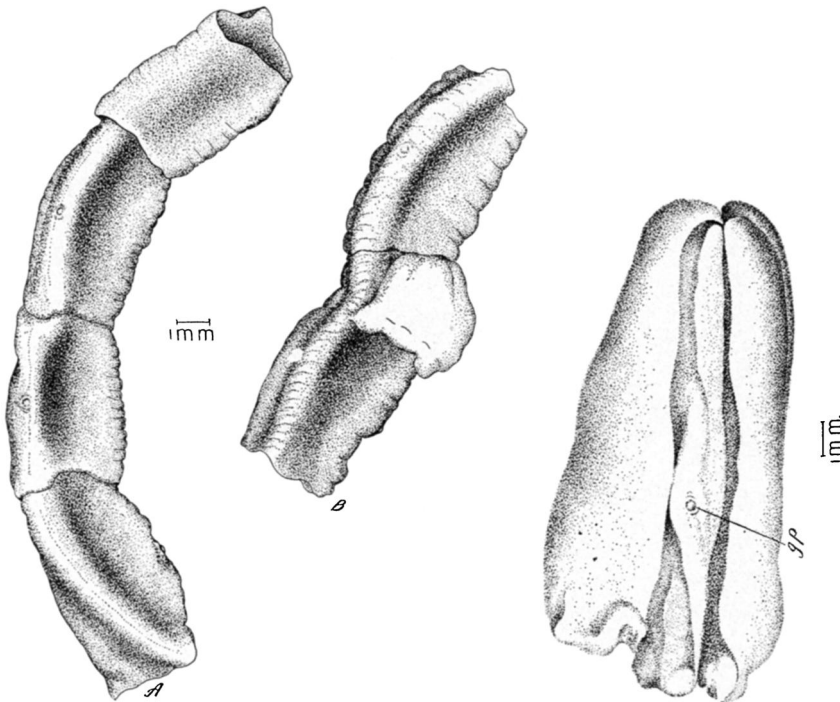


Figure 1

Figure 3

Fig. 1.—A. Portion of a triradiate *Taenia pisiformis*, showing the twisting of the strobila, and consequent displacement of the papilliferous wing. B. Another portion of the same specimen showing a supernumary proglottid without genital pore. [Original.]

Fig. 3.—A tetraradiate proglottid of *Taenia saginata*. gp, genital pore. [Original.]

the formalin in which the specimen was sent, the genital pores are very difficult to observe in unmounted proglottids. As far as could be determined, however, there is but one pore to each segment, and it is always on the edge of the same wing. Owing to a spiral twist extending irregularly throughout the greater part of the strobila, the papilliferous wing of a given segment is seldom in line with the same wing in the

adjacent segments. Thus in Figure 1 A, while the two middle segments have the papilliferous wing on top, in the bottom segment it is on the right-hand side, while in the upper segment it is underneath. That this shifting of the papilliferous wing is due to the spiral twist and not to the fact that the pore may be on any one of the three wings, is made evident by finding the pores all in a straight line in those parts of the strobila not affected by the spiral twist. The longest proglottid was 13 mm. long by 2.5 mm. wide. The average was 7 mm. by 3.5 mm. Only one supernumerary proglottid was seen (Fig. 1 B). This was

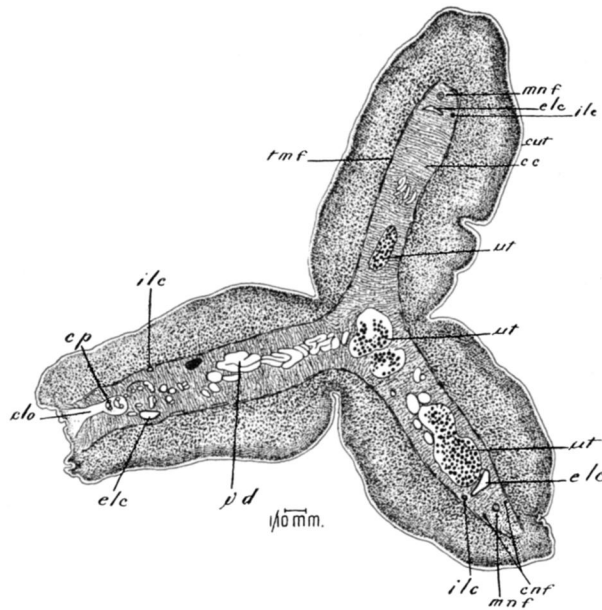


Fig. 2.—Cross section through a gravid proglottid of a triradiate *Taenia pisiformis*, in the region of the genital pore. *cc*, calcareous corpuscles; *clo*, cloaca; *cnf*, concomitant nerve fasciculi; *cp*, cirrus pouch; *cut*, cuticle; *elc*, external longitudinal canal; *ilc*, internal longitudinal canal; *mnf*, medullary nerve fasciculus; *tmf*, transverse muscle fibers; *ut*, uterus; *vd*, vas deferens. [Original.]

interpolated between two normal segments and affected only one wing, as the line of demarcation between it and the usual triradiate proglottid did not extend through all three wings. The supernumerary proglottid had no genital pore.

As in the other cases of triradiate cestodes, the sexual organs are found in all three wings. In ripe proglottids the uterus is seen to occupy the central portion of the body (Fig. 2), sending out branches into each wing. The eggs appear in all respects normal. Two longitudinal canals, the larger external and the smaller internal, appear in

each wing near the margin. The relative position of these canals varies both in different proglottids and in the different wings of the same proglottid. In the drawing (Fig. 2), the canals occur laterally, the ventral canal being much the larger. The principal longitudinal nerve, the medullary fasciculus, is between these canals and the margin of the wing, one in each wing. In one wing two accessory fasciculi could be seen on either side of the medullary fasciculus. The vas deferens at the plane of the section drawn occupies most of the medullary layer of one of the wings (Fig. 2), and, extending into the cloaca, passes between the two longitudinal canals. In mature proglottids the testes are distributed scatteringly throughout the three wings, being less numerous in the region of the vas deferens. As in normal proglottids, the ovaries occupy the central portion of the posterior half, and send out ramifications in all directions. The arrangement of the transverse and longitudinal muscle fibers, calcareous corpuscles and all other organs are, as far as observed, no different from that seen in normal cestodes of this species.

TETRARADIATE AND PENTARADIATE CESTODES

Only one case (Rosenberger, 1903) of an adult cestode having more than three wings throughout its strobila, has thus far been reported. That such an anomaly might exist was, however, anticipated by Railliet (1899), who examined a number of scolices of *Coenurus serialis* and found specimens having suckers ranging in number from three to ten. Railliet states in conclusion: "If the rule appears well established that a *Taenia* larva with six suckers will produce a worm with a triradiate chain, what malformation will arise from scolices having 3, 5, 8, 9, and 10 suckers?" In view of the assumed relation between the number of suckers of the scolex and the wings of the strobila, it is reasonable to suppose that Rosenberger's (1903) case of a pentaradiate *Taenia saginata* developed from a cysticercus with ten suckers, and that the present writer's case of a tettraradiate *Taenia saginata* was derived from an eight-suckered cysticercus.

Rosenberger (1903) received from a physician in Colorado a section of several proglottids of *Taenia saginata* having a "star-shaped" figure. The specimen was sent to Dr. Mohler of this bureau. Rosenberger's (1903) brief note includes a figure showing a chain of four proglottids having four equal or subequal wings radiating from a common center. As Rosenberger does not give the number of wings to his specimen and merely characterizes it as "star-shaped," the writer asked Dr. Mohler for further information. Dr. Mohler stated that according to his recollection there were five wings radiating from a common

center, giving the star-shaped figure described, and that the fifth wing did not appear in the drawing since it was hidden from view by the other wings. No detailed study was made of the specimen and the number and arrangement of the genital pores was not observed. Dr. Mohler was under the impression that the specimen had been deposited in the Helminthological Collections of the United States National Museum, but it could not be found. In looking through the material, however, a tetrastrate specimen was found, described below.

This specimen (No. 3269, Helminthological Collections, United States National Museum) consists of one proglottid only. The material was determined by Stiles in 1901 and collected the same year. Except for the name of the species (*Taenia saginata*) and the host,

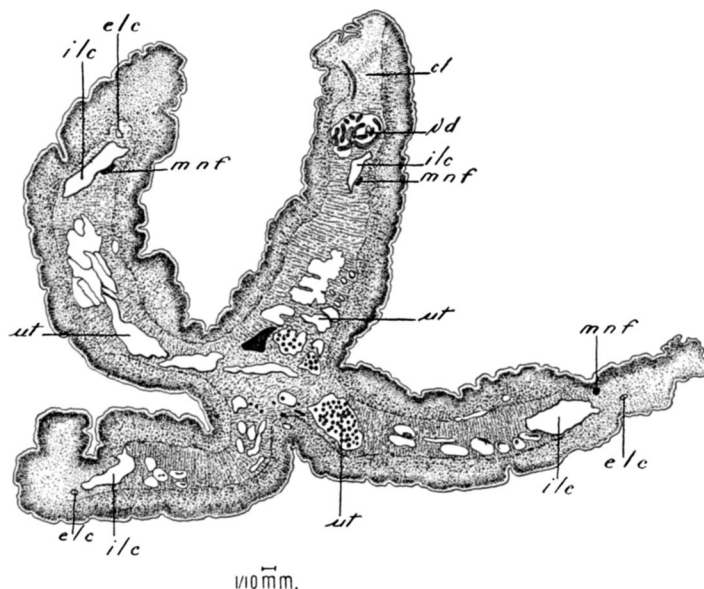


Fig. 4.—Cross section through a tetrastrate proglottid of *Taenia saginata*, in the region of the genital pore. *cl*, cloaca; *elc*, external longitudinal canal; *ilc*, internal longitudinal canal; *mnf*, medullary nerve fasciculus; *ut*, uterus; *vd*, vas deferens. [Original.]

no further information is given on the label. The proglottid is 15 mm. long with a maximum width of 8 mm. at the posterior extremity, which is considerably wider than the anterior end (Fig. 3). Three of the wings are of fairly equal width, the fourth wing, largely concealed in the drawing (Fig. 3), is considerably shorter than the others. There is but one genital pore, placed somewhat posterior to the middle of the segment, on the edge of the middle one of the three equal wings.

In cross-section (Fig. 4) the wings are seen to form an asymmetrical tetrastrate figure, the gravid uterus extending into each wing.

A large internal excretory canal of irregularly triangular outline is seen near the external edge of each wing. The smaller external canal appears between the internal canal and the outside edge. The uterine branches extending into all four wings are in most sections devoid of eggs and appear as large irregular lacunae in the medullary layer. A few eggs, however, appear in the main uterine stem (Fig. 4). The principal longitudinal medullary fasciculus is seen close to the wall of the internal canal, apparently flattened out by pressure from the adjacent longitudinal canal. The coiled vas deferens and the outline of the cloaca is seen in the middle of the three subequal wings.

ORIGIN OF POLYRADIATE CESTODES

Triradiate cestodes are sometimes referred to as being a fusion of two normal individuals; it would seem more logical, however, to consider them as representing the fusion of one cestode with half of another individual, since we invariably find six suckers to these triradiate forms and not eight, which we would expect if two individuals were blended. If, however, there were a true fusion we should expect to find a line of union, which does not appear in cross-sections. Moreover, if a cestode having irregularly alternate papillae were joined to another individual, we should expect to find about half of the proglottids with two genital pores and half with only one, yet it is usual to find only one genital pore to a segment, and that on the same wing throughout the strobila. From the fact that cysticerci with six suckers are occasionally found, and that oncospheres with more than six hooklets have been observed, it was suggested by Davaine (according to Railliet, 1899) that the cause of this abnormality originated in the egg. This view is, however, disputed by Leuckart (1880) and Railliet (1892), who point to the fact that in a coenurus, several of the scolices may have an abnormal number of suckers while the others are normal, yet all must have originated from the same oncosphere.

FEEDING EXPERIMENTS WITH TRIRADIATE TAENIA PISIFORMIS

In view of the fact that oncospheres with eight hooklets and cysticerci with six suckers have been found, it seems reasonable to expect that these forms would originate from a triradiate tapeworm, and Küchenmeister and Zürn (1878-81) and Railliet (1892) have suggested the advisability of feeding experiments to determine their origin. These authors were, however, unable to carry out the suggestion from lack of material.

Although the triradiate *Taenia pisiformis* described by the present writer was shipped in a solution of formalin of unknown strength, and kept in a 2 per cent. solution of formalin for one week after it

TABULAR LIST OF CASES OF POLYRADIATE CESTODES *

Author	Date	Species	Locality	No. of Specimens	Appearance of Head	Shape of Strobila
Andry	1741	<i>T. saginata?</i>	France	1	Unknown	Triradiate?
Rudolphi	1810	<i>Dipylidium caninum</i>	Germany?	1	Normal	Triradiate
Brera	1810	<i>T. saginata?</i>	Switzerland?	1	Unknown	Triradiate?
Bremser	1819	<i>T. saginata?</i>	Austria?	1	Missing	Triradiate
Bremser	1819	<i>T. taeniaeformis</i>	Austria?	1	6 suckers	Triradiate
Levacher	1841	<i>T. saginata?</i>	France	1	Unknown	Triradiate
Siebold	1853	<i>T. echinococcus</i>	Germany?	1	6 suckers	Triradiate
Küchenmeister	1855	<i>T. coenurus</i>	Germany?	2	6 suckers	Triradiate
Küchenmeister	1855	<i>T. saginata</i>	Cape Good Hope	1	Missing	Triradiate
Zenker	1861	<i>T. solium</i>	Germany?	1	6 suckers	Triradiate
Krause	1863	<i>C. cellulosae</i>	Germany	1	6 suckers	.....
Cobbold	1866	<i>T. saginata</i>	England	1	Missing	Triradiate
Vaillant	1870	<i>T. saginata?</i>	France	1	Missing	Triradiate
Cullingworth	1873	<i>T. saginata</i>	England	1	Missing	Triradiate
Küchenmeister & Zürn	1878-1881	<i>C. cerebralis</i>	Germany	2	6 suckers	.....
Leukart	1880	<i>T. coenurus</i>	Germany	1	6 suckers	Triradiate
Leukart	1880	<i>T. saginata</i>	Germany	1	Missing	Triradiate
Laker	1885	<i>T. solium</i>	Germany	2	6 suckers	Triradiate
Trabut	1889	<i>T. saginata</i>	Tonkin	1	6 suckers	Triradiate
Neumann	1890	<i>Anoplocephala perfoliata</i>	France	1	6 suckers	Triradiate
Coats	1891	<i>T. saginata</i>	Scotland	1	Missing	Triradiate
Bork	1891	<i>T. saginata</i>	Germany	1	Missing	Triradiate
Railliet	1892	<i>C. pisiformis</i>	France	1	6 suckers	.....
Küchel	1892	<i>T. saginata</i>	East Africa?	1	6 suckers	Triradiate
v. Linstow ...	1892	<i>Bothriocephalus tectus</i>	{ S. Georgia Antarctic reg.	Several	Missing	Triradiate
Monticelli ...	1893	<i>T. saginata?</i>	Italy?	1	Missing	Triradiate
Barrois	1893	<i>T. saginata</i>	France	1	Missing	Triradiate
Pittard (after Railliet) ...	1895	<i>Bothriocephalus latus</i>	England?	1	Unknown	Triradiate
Shennan	1898	<i>T. saginata</i>	Scotland	1	Missing	.....
Klepp	1898	<i>C. cellulosae</i>	Germany	1	6 suckers	.....
Zürn	1898	<i>C. tenuicollis</i>	Germany	Several	6 suckers	.....
Railliet	1899	<i>C. serialis</i>	France	Several	2, 3, 6, 8, 10 suckers	.....
Cattaert	1899	<i>T. saginata</i>	France	1	Missing	Triradiate
Neveu-Lemaire	1900	<i>T. saginata</i>	France	2	1 case none	.....
Jelden	1900	<i>T. saginata</i>	Germany	1	6 suckers	Triradiate
Lohoff	1902	<i>C. bovis</i>	Germany	1	6 suckers	.....
Vigener	1903	<i>T. saginata</i>	Germany	1	6 suckers	Triradiate
Rosenberger ..	1903	<i>T. saginata</i>	Colorado, U.S.A.	1	Missing	Pentaradiate
Galli-Valerio ..	1909	<i>Coenurus serialis</i>	Switzerland?	1	6 suckers	.....
MacCallum ..	1912	<i>T. saginata</i>	Canada	1	Missing	Triradiate
Yoshida	1913	<i>T. taeniaeformis</i>	Japan	1	6 suckers	Triradiate
McCulloch ...	1913	<i>T. saginata</i>	Missouri, U.S.A.	1	Missing	Triradiate
Foster	1915	<i>T. saginata</i>	U. S. A.?	1	Missing	Tetraradiate
Foster	1915	<i>T. pisiformis</i>	Europe	1	Missing	Triradiate

* In those cases where the species has been imperfectly described so that there is some doubt whether the cestode seen belonged to *Taenia saginata* or *T. solium*, the cestode is assigned to the species *saginata* followed by an interrogation point, as this species is the more numerous in most countries. Where the writer has failed to state the country from which the worm was collected, the locality given is that of the country in which he lived when the case was published (as far as could be determined). These doubtful localities are also marked by an interrogation point. In the last column marked "Shape of Strobila," the interrogation points indicate that the specimens were so imperfectly described that it is not certain whether they were triradiate forms or not. The dotted lines in this column indicate that the cestodes described are larval forms and hence have no strobilae.

was received, it was determined to use some of the material for feeding experiments. The writer was encouraged in the hope that the vitality of the eggs would prove unaffected by the formalin, from the fact that on several previous occasions he had fed to rabbits, proglottids which had been shipped in formalin and had always succeeded in infesting the animals. In the previous cases, however, the feeding experiments were performed as soon as the material was received.

A rabbit reared at the experiment station of the Bureau of Animal Industry was fed May, 1914, with two proglottids of the triradiate *Taenia pisiformis* already described. The rabbit died June 4, 1915. The postmortem revealed seven cysticerci, three of which were attached to the omentum, the others lying loose in the body cavity. The cysticerci were all fully grown and surrounded by a protective membrane, the largest cyst measuring 2 cm. long by 1 cm. in diameter. In dissecting out the invaginated scolices to determine the number of suckers, two specimens were mutilated and the number of suckers could not be positively determined. There is no reason to suppose, however, that more than the usual number of suckers were present. The other five specimens were entirely normal.

It can not be positively demonstrated that the rabbit was uninfested with *Cysticercus pisiformis* at the time it was fed. On the other hand, the fact that the rabbit was reared and kept in a cage until its death, and that as far as the writer is aware no rabbits from this source have been found infested with *C. pisiformis* unless as the result of feeding experiments, is very strong evidence for assuming that the cysticerci found resulted from the feeding experiment and not from a previous infestation.

The experiment therefore failed to prove that cestode larvae with an excessive number of suckers are the offspring of polyradiate adults. On the other hand, it appears that a triradiate cestode may give rise to perfectly normal larvae, which presumably would develop into normal adults. Whether or not cestode larvae with an excessive number of suckers have any genetic connection with polyradiate adult cestodes, is a question still remaining unanswered.

SUMMARY

1. The term polyradiate is used to designate those cestodes whose strobila is uniformly divided into three or more rays or wings extending throughout the entire strobila and radiating from a common axis, and whose scolices have two suckers for each of the rays present. Presumably the larvae of these polyradiate forms have as many suckers as appear in the scolices of the adults.

2. Altogether forty-four cases of polyradiate cestodes (including larvae) have been reported, in all but two of which the adult forms were triradiate. The greater number of cases are triradiate forms of *Taenia saginata*, but several species are represented and they are found in widely distributed localities. The greater frequency of this anomaly in *T. saginata* is probably due to the greater chances for observation of this species.

3. Of the two cases having more than three rays, one is apparently pentaradiate (Rosenberger's case), and the other is tetraradiate (Foster's case, the present paper); both are specimens of *Taenia saginata*. Since triradiate forms are assumed to originate from larvae with six suckers, it is suggested that the tetraradiate and pentaradiate forms originated from cysticerci having 8 and 10 suckers, respectively, larvae with this number of suckers having been found by Railliet (1899) in the case of *Coenurus serialis*.

4. The view that the origin of polyradiate forms can be traced to the ovum, is supported by the finding of oncospheres having an excessive number of hooklets. On the other hand, this view is disputed by the finding of both normal and abnormal scolices in the same coenurus. A feeding experiment with triradiate proglottids of *Taenia pisiformis* tends to show that in this species perfectly normal cysticerci may result from abnormal adults. Whether or not cysticerci with an excessive number of suckers and oncospheres with an excessive number of hooklets have any genetic connection with polyradiate adults, is a question which has not yet been solved.

BIBLIOGRAPHY

For complete citation of articles reported in this paper see Index Catalog of Medical and Veterinary Zoology, Bull. 39, Bureau Animal Industry, U. S. Dept. Agric.

The following papers have appeared since the completion of that catalogue.

MacCallum, G. A. 1912. Malformation of *Taenia saginata* (T. trièdre), Med. Rec., N. Y., 81 (12), March 23, 562-563.

McCulloch, Hugh. 1913. Cestode Monstrosities, Am. Jour. Trop. Dis. [etc.], N. Orl., 1 (6), December, 453-461.

Yoshida, S. O. 1913. Triradiate *Taenia crassicollis*. Parasitology, Cambridge [Eng.], 6 (3), October, 278-282.